5.4 Earth-termination system

5.4.1 General

When dealing with the dispersion of the lightning current (high frequency behaviour) into the ground, whilst minimizing any potentially dangerous overvoltages, the shape and dimensions of the earth-termination system are the important criteria. In general, a low earthing resistance (if possible lower than 10 Ω when measured at low frequency) is recommended.

From the viewpoint of lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems).

Earth-termination systems shall be bonded in accordance with the requirements of 6.2.

NOTE 1 The conditions of separation and bonding of other earth-termination systems are usually determined by the appropriate national authorities.

NOTE 2 Serious corrosion problems can occur when earthing systems made of different materials are connected to each other.

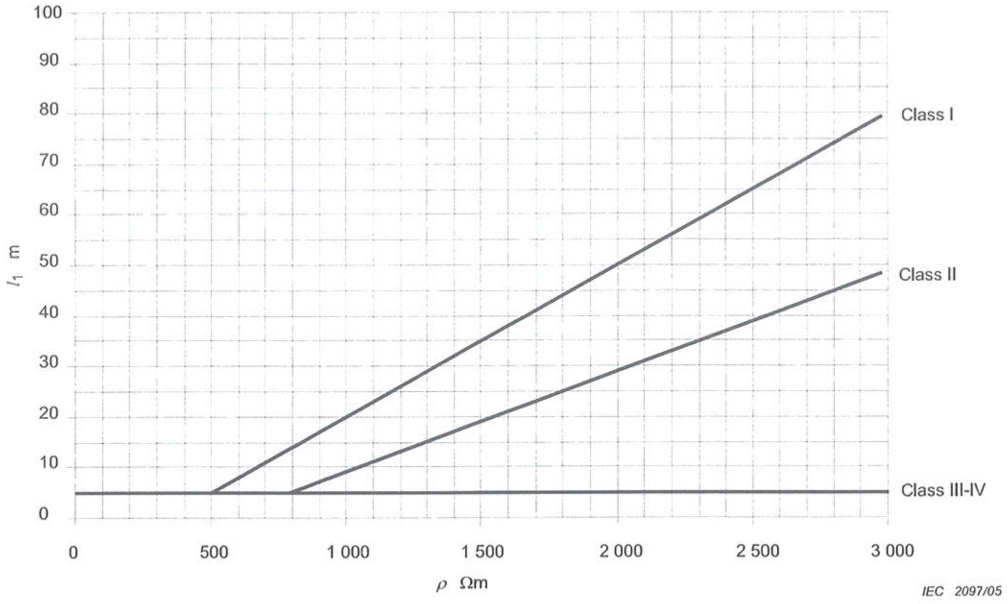
5.4.2 Earthing arrangement in general conditions

For earth-termination systems, two basic types of earth electrode arrangements apply.

5.4.2.1 Type A arrangement

This type of arrangement comprises horizontal or vertical earth electrodes installed outside the structure to be protected connected to each down-conductor.

In type A arrangements, the total number of earth electrodes shall be not less than two.



NOTE Classes III and IV are independent of soil resistivity.

Figure 2 – Minimum length l_1 of each earth electrode according to the class of LPS

Earth electrodes shall be installed in such a way as to allow inspection during construction.

The embedded depth and the type of earth electrodes shall be such as to minimize the effects of corrosion, soil drying and freezing and thereby stabilize the conventional earth resistance. It is recommended that the upper part of a vertical earth electrode equal to the depth of freezing soil should not be regarded as being effective under frost conditions.

NOTE Hence, for every vertical electrode, 0,5 m should be added to the value of the length l_1, calculated in 5.4.2.1 and 5.4.2.2.

For bare solid rock, only type B earthing arrangement is recommended.

For structures with extensive electronic systems or with high risk of fire (see IEC 62305-2), type B earthing arrangement is preferable.

5.4.4 Natural earth electrodes

Interconnected reinforcing steel in concrete foundations in accordance with 5.6, or other suitable underground metal structures, should preferably be used as an earth electrode. When the metallic reinforcement in concrete is used as an earth electrode, special care shall be exercised at the interconnections to prevent mechanical splitting of the concrete.

NOTE 1 In the case of pre-stressed concrete, consideration should be given to the consequences of the passage of lightning discharge currents which may produce unacceptable mechanical stresses.

NOTE 2 If a foundation earth electrode is used, a long-term increase in earthing resistance is possible.

NOTE 3 More extensive information on this topic is reported in Annex E.

5.5 Components

Components of an LPS shall withstand the electromagnetic effects of lightning current and predictable accidental stresses without being damaged.

Components of an LPS shall be manufactured from the materials listed in Table 5 or from other materials with equivalent mechanical, electrical and chemical (corrosion) performance characteristics.

NOTE Components made of material other than metal may be used for fixing.

Loops in a conductor as shown in Figure 1 can produce high inductive voltage drops, which can cause a lightning discharge to pass through a structure wall thereby causing damage.

If the conditions in 6.3 are not met, arrangements should be made for direct routing through the structure at the points of re-entrant lightning conductor loops for those conditions shown in Figure 1.

E.4.3 Reinforced concrete structures

E.4.3.1 General

Industrial structures frequently comprise sections of reinforced concrete which are produced on site. In many other cases, parts of the structure may consist of prefabricated concrete units or steel parts.

Steel reinforcement in reinforced concrete structures conforming to 4.3 may be used as a natural component of the LPS.

Such natural components must fulfil the requirements of:

- down-conductors according to 5.3;
- earth-termination networks according to 5.4.

Moreover, the conductive reinforcement of concrete, when properly used, should form the cage for potential equalization of the internal LPS according to 6.2.

Furthermore, the steel reinforcement of the structure, if adequate, may serve as an electromagnetic shield, which assists in protecting electrical and electronic equipment from interference caused by lightning electromagnetic fields according to IEC 62305-4.

If the reinforcement of the concrete and any other steel constructions of a structure are connected both externally and internally so that the electrical continuity conforms to 4.3, effective protection may be achieved against physical damage.

The current injected into the reinforcing rods is assumed to flow through a large number of parallel paths. The impedance of the resulting mesh is thus low and, as a consequence, the voltage drop due to the lightning current is also low. The magnetic field generated by the current in the reinforcing steel mesh is weak due to the low current density and the parallel current paths generating opposing electromagnetic fields. Interference with neighbouring internal electrical conductors is correspondingly reduced.

NOTE For protection against electromagnetic interference, see IEC 62305-4 and IEC 61000-5-2.

When a room is totally enclosed by steel-reinforced concrete walls whose electrical continuity conforms to 4.3, the magnetic field due to lightning current flowing through the reinforcement in the vicinity of the walls is lower than that in a room of a structure protected with conventional down-conductors. Owing to the lower induced voltages in conductor loops installed inside the room, protection against failures of internal systems may be easily improved.

After the construction phase, it is nearly impossible to determine the layout and construction of the reinforcement steel. Therefore, the layout of the reinforcement steel for the purpose of lightning protection should be very well documented. This can be done utilizing drawings, descriptions and photographs taken during the construction.